International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM 2014 vol.1, pages 743-750

New opportunities of high-resolution gravimetry for the studies of subsurface geology and prediction of oil fields

Slepak Z.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© SGEM2014. All Rights Reserved. Detailed analysis of rock density using laboratory and well logging data enabled the author to identify key features that characterize its variability in the areas of many local structures (uplifts) identified by exploration drilling. It was established that on the structural crests the rock is prone to unconsolidation that can be traced throughout the entire sedimentary cover while some layers of compacted rock can be also encountered. Such parts of the structures generally exhibit extensive secondary alteration of rock and contain the areas of ground water discharge above the basement faults. Forward modeling established that the main change in gravity occurs due to unconsolidation of rock that is one order of magnitude greater than the effect of the density contrasts and oil pools. High-resolution gravimetric data acquired along the survey lines across the structures allows tracking local gravity lows to 1–2 mGal created by lateral unconsolidation of rock. These gravity lows are indicative of the presence of structures and are reliably tracked over the local uplifts of various morphologic and genetic styles. With consideration for the established regularities that characterize variability of the rock density and using the output of forward modeling, the author of this paper has proposed the method of gravity modeling for identification of anomalous changes of the gravity field in the areas of predicted structures and for their geologic characterization. Involving the solution of reversed linear problem in gravity exploration directly by using Bouguer effects, the proposed method permits the construction of physical geological models of the predicted subsurface features that reflect the peculiarities of the geology of oil fields, and also permits evaluation of their certainty using the available information. Studies of geological structure of oil fields include high-resolution gravity measurements along the survey lines across the strike of predicted subsurface structures. Anomalous changes of the gravity field created by the lateral variability of rock on the local structures are reliably tracked. [1,3]. Further, 3D density models reflecting the details of subsurface geology of the oil fields are built using the data of field gravity surveys. In contrast to gravity modeling, identification of the anomalies created by lateral heterogeneity of the density of rock in different parts of the structures using the gravity maps is challenging. State-of-the-art software processing significantly improves the level of geologic information received by solving inverse problems and reliability of prediction of the oil pools. Additional details of the density variability in the areas of interest are observed in the course of 3D density modeling, which is very important for the future drilling projects and improved efficiency of petroleum exploration. This paper discusses the case studies of successful appraisal of subsurface geology of the oil fields that were further confirmed by the drilling.

Keywords

Geology, Gravimetry, Modeling, Oil field prediction